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EXPLOSION AND FIRE PREVENTION
IN
SCHOOL BUILDINGS

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Fire Department Instructors' Conference
Memphis, Tennessee
January 10, 1940

NATURAL GAS EXPLOSIONS IN SCHOOL BUILDINGS

Records available indicate that explosions of natural gas have been responsible for at least three serious accidents involving school structures. These three occurrences in a little over three years' time should serve as adequate warning that natural gas installations must be made in accordance with recognized safety practices by workmen trained in gas installations and also that natural gas should carry a malodorant to give warning of its presence. The greatest school disaster of the present century took place when a gas explosion on March 18, 1937 destroyed the Consolidated High School at New London, Texas, with the loss of 293 lives - 276 pupils and 17 teachers.

It is worthy of note that two of these gas explosions occurred in buildings of fire-resistive construction. While fire-resistive construction is very desirable to prevent children from being trapped by flames, lack of combustible structural members may not alone provide complete safety if the building is so arranged that accumulations of escaping gas may explode beneath the structure and wreck the building.

(1) High School, New London, Texas, March 18, 1937:

It has been established that this explosion was due to an accumulation of leaking gas under the first floor of the building, and that the ignition was from the arc of an electric switch in the manual training room located close to a trap door leading into the basement.

The school building was of fire-resistive construction and planned for reasonable safety, except for the gas piping which had been installed by local school employees with no apparent regard for the National Fire Protection Association Good Practice Requirements, which give detailed provisions for installation and tests to avoid danger of leaks. Furthermore, the gas was not odorized to give warning of leaks. The excessive area of concealed space under the building was poor practice for a structure of this type and occupancy, but not necessarily a structural weakness in itself. When bottled up with virtually no ventilation, however, and filled with gas pipe lines and electrical circuits, it became a serious fault.

The New London explosion has shown that practically all faults of construction and installation in the school building were due to lack of supervisory power such as would apply in communities having proper city ordinances. This explosion serves to focus attention on the need for state laws or standards of construction as well as approved standards for the installation of heating systems, electrical equipment, gas and oil systems, and all features affecting the welfare of the public in schools, public buildings and all other buildings where large numbers of people congregate.

(2) Oklahoma A & M College, Stillwater, Okla., November 13, 1936:

A three story fire-resistive building known as Whitehurst Hall and occupied by college administrative offices, library, lecture rooms and laboratories of Oklahoma A & M College was severely damaged by an explosion of natural gas. The explosion was due to ignition of natural gas in a pipe tunnel under the building. The natural gas did not contain a malodorant and the odor of gas had not been observed on the day of this explosion, although gas odors had been detected for several weeks prior to the fire. The explosion occurred when two student employees were about to enter the pipe tunnel to repair an obstructed sewer drain. Apparently the bulb of an extension light became broken, igniting the gas. Of the twelve persons in the areas affected by the explosion, five were injured. It was fortunate that the explosion did not occur when the building was fully occupied and that the explosion was not severe enough to cause the collapse of the structure. While the explosion damage was confined to the first floor, it was considered advisable to replace the structure with a new building.

(3) Public School, Barberton, Ohio, May 31, 1939:

Explosions of natural gas on the day before the end of the school session in a former dwelling being used as a temporary public school injured 52 children and 4 employees. The two story frame building in which the explosion occurred was being used as temporary quarters for three classes totaling 101 children of the age of six and seven years. Three teachers and the janitor were also in the building and were among the injured.

An accumulation of natural gas in the basement was ignited when the janitor struck a match to burn some paper in the furnace. The natural gas involved in the explosion was not odorized, as it was considered to have enough odor to give reasonable warning in the event of a leak. No gas had been used in the building since the school authorities took possession, and the gas service was shut off at the meter. Workmen, in digging down to the gas service pipe, discovered a break in the pipe about eight feet from the building wall. Apparently some gas had escaped from the break and followed the pipe into the building. The failure of the pipe may have resulted when a sewer excavation was made nearby.

It was very fortunate in this explosion that a great loss of life did not occur. Had the building been of more substantial construction, confining the force of the explosion and providing heavier debris, it seems likely that there would have been heavy loss of life. It was also fortunate that a serious fire did not occur before the injured were removed from the wreckage.

LOSS OF LIFE IN SCHOOL FIRES

There have been 60 school fires since 1903 in which loss of life occurred. In these 60 fires, 827 lives were lost and several hundred injured. In the total of 827,- 678 were children. A number of fires have taken place in which employees or firemen, rather than children, were the victims. The number of recorded deaths among those fighting school fires is far greater than in other similar occupancies - perhaps due to structural conditions or because of a zeal in fire fighting due to a special sense of responsibility for the safety of schools.

The loss of life per fatal school fire is high, 13.8 persons. This figure is greater than the figure of 8.3 per fire for institutional occupancies, and much higher than the figure of 1.5 per fatal fire in dwellings, or the figure of 6 per fire in other occupancies.

CAUSES OF LOSS OF LIFE IN SCHOOL FIRES

In the following table 470 fatalities are classified according to the immediate cause of the loss of life, rather than according to the cause of the fire:

	Number of Deaths			
Construction	Public Schools	Private Schools	Colleges	Total
1) Inadequate exits	252	5	52	309
2) Night fire, people asleep, no data as to how deaths were caused . .	0	26	28	54
3) Exit doors opened in - barred windows	36	0	0	36
4) Suffocated while asleep	0	28	0	28
5) Fire coming up basement stairs - cut off exit	22	1	0	23
6) Fire coming up from 1st floor - cut off second	12	1	3	16
7) Attempted to descend inside stairs .	2	0	1	3
8) Trapped in attic	1	0	0	1
Total				470

Inadequate exits were responsible for almost 2/3 or 66 percent of life loss in these fires.

In the following table the loss of a total of 827 lives in school fires is classified according to occupancy:

	Total Fires	Men	Women	Children	No Data	Total Lives Lost
High Schools	15	18	12	279	1	310
Elementary Schools. .	15	16	23	286	15	340
Dormitories	25	27	30	113	0	170
Other buildings . . .	5	5	2	0	0	7
	60	66	67	678	16	827

Almost 80 percent of the loss of live occurred in elementary schools and high schools.

SOME MAJOR SCHOOL DISASTERS

The following eight major school disasters were responsible for 693 deaths:

(1) Consolidated High School, New London, Texas, March 18, 1937 - (gas explosion)	293
(2) Lakeview School, Collinwood, Ohio, March 4, 1908 - (panic in stairway)	175
(3) Cleveland School, Camden, S. C., May 17, 1923 - (oil lamp igniting wooden ceiling	77
(4) Sacred Heart College, St. Hyacinthe, Quebec, January 18, 1938 - (combustible interior construction)	46
(5) Rural School, Babbs Switch, Okla., December 24, 1924 - (candles on Christmas tree)	36
(6) Development School, Playa del Rey, Calif., May 31, 1924 - (started by inmate)	24
(7) Parochial School, Peabody, Mass., October 28, 1915 - (lack of adequate exit facilities)	22
(8) Beauval (Indian) Mission School, Lac La Plonge, Saskatchewan, Sept. 19, 1907 - (lack of fire drill in boy's dormitory)	20
Total	693

RECORDS OF 1000 SCHOOL FIRES

The Department of Fire Records, National Fire Protection Association, has classified 1000 school fires occurring between January 1, 1928 and August 1, 1939. These records indicate that fires occur in school property at the rate of six or seven a day in the United States and nearly one a day in Canada. The total school fire loss in the United States and Canada is estimated at over $6,000,000 yearly.

These 1000 fires can be classified according to kind of school as follows:

Kind of School in Which Fires Occurred

	No. Fires
(1) Public Elementary Schools	287
(2) Public High and Junior High Schools	255
(3) Colleges, Universities and Normal Schools	257
(4) Private Schools and Convents	128
(5) Parochial High and Elementary Schools	45
(6) Business and Trade Schools	28
Total	1,000

It is apparent that certain types of schools have similar fire hazards. High and elementary public schools are usually housed in buildings used for no other purpose, where the buildings, even in the city, frequently occupy a position relatively isolated from other buildings. Parochial schools and convents are frequently in or adjacent to church property. Business schools are often in mercantile or office buildings, as are some trade schools. Boarding schools range from the small private school where living and classrooms are all under a single roof, to a large academy type of institution which has a group of buildings comparable to a university or college property. A building used as a dormitory has the same hazard, regardless of whether it is part of a university, private boarding school, normal or trade school or convent. A building used for classrooms, laboratories, etc., is as hazardous as a part of a university as if a part of a private school.

Types of Buildings Involved

		No. of Fires
Classroom buildings		720
Dormitories		165
Workshop and Laboratory building		33
Gymnasiums		20
School store and office buildings		16
Service Buildings		19
Chapels or auditoriums		11
Recreation buildings		8
Libraries		3
Miscellaneous buildings		5
Barn or stable	2	
Armory	1	
Garage	1	
Museums	1	
Total		1,000

LOCATION OF ORIGIN OF FIRE

In studying the location of the origin of the fire, it has been found that classroom fires are a serious problem in elementary schools. Much of this unfortunately has been attributed to vandalism directed against unpopular teachers.

The basement of an elementary school is a relatively greater hazard than the basement of a high school. This is probably due to the fact that high school basements are usually finished and house classrooms, lunch rooms, locker rooms, gymnasiums, etc., and are accordingly kept cleaned up. The average elementary school basement, on the other hand, is unfinished and frequently its otherwise unoccupied spaces become catch-alls for old furniture and rubbish. The heating plants of elementary schools are often not so well installed as in the larger high school buildings.

CAUSES OF SCHOOL FIRES

Causes of School Fires from N.F.P.A. Fire Record

	Public Element. Schools	Public High & Jr. High Schools	Colleges & Normal Schools	Private Schools & Convents	Parochial Schools	Business & Trade Schools	Total
(1) Electrical Causes	25	28	23	15	5	1	97
(2) Smoking - matches	19	12	25	10	3	5	74
(3) Incendiary	29	26	8	7	2	0	72
(4) Defective or overheated heating equipment	26	11	14	8	7	2	68
(5) Spontaneous ignition	14	26	14	5	2	5	66
(6) Ignition of flammable liquid or gases	7	11	23	3	2	2	48
(7) Defective or overheated flue or chimney	13	13	10	6	3	0	45
(8) Sparks on wooden shingle roof	11	7	9	3	1	0	31
(9) Rubbish and litter	13	5	7	2	1	1	29
(10) Sparks from fireplace or stove	1	0	8	7	0	0	16
(11) Chemicals	0	5	6	0	0	0	11
(12) Lightning	2	1	2	4	0	1	10
(13) Acetylene or gasoline torch	3	3	2	1	0	0	9
(14) Defective oil burner	2	0	3	0	3	0	8
(15) Motion picture film ignited	1	4	2	0	0	0	7
(16) Electric iron left on unattended	0	0	2	3	0	1	6
(17) Exposure to other fires	1	2	1	1	0	0	5
(18) Steam pipes ignited woodwork	1	0	1	0	0	1	3
(19) Miscellaneous causes	5	4	6	1	2	0	18
(20) Unknown causes	114	97	91	52	14	9	377
Total	287	255	257	128	45	28	1,000

The first seven causes listed are responsible for 470 out of 623, or over 75 percent of the fires listed in the N.F.P.A. fire record for which the cause is known.

LIFE SAFETY FROM SCHOOL FIRES

The Building Exits Code developed by the Committee on Safety to Life of the National Fire Protection Association outlines the fundamental requirements necessary for reasonable safety to life in school buildings. These recommendations can be summarized as follows:

(1) The material of building construction, while important, is less significant than various other factors of design and arrangement. For instance, a building can be constructed entirely of fireproof materials and still present a severe life hazard if the stairways are open to permit the rapid spread of fire and smoke, and if the combustible contents are not properly protected.

(2) The smoke hazard is just as important as fire itself. The majority of fire deaths are due to the effects of smoke rather than actual burns. Even a relatively slight amount of smoke may cause a fatal panic.

(3) One of the first principles of construction is that stairways and other vertical shaft openings must be enclosed so as to restrict the upward spread of fire and smoke and to afford a safe path of escape down the stairways for those on upper floors.

(4) The one story school, so arranged as to afford direct access to the outside from any part of the building is the safest design, and when this form of design is used there is little restriction as to type of construction.

(5) Exits should be so arranged that from any part of the building there will be at least two separate means of escape, so located that in case fire or smoke therefrom interferes with the use of one, another exit will be readily available.

(6) Stairs must be properly designed, doors must swing with the exit travel, handrails, lighting, etc., must conform with accepted standards.

(7) Outside fire escapes are inferior in numerous respects to standard interior stair exits and are recognized only as an expedient to rectify exit deficiency in existing buildings where the expense of providing additional interior stairways might be prohibitive.

(8) Effective use of exits requires a fire alarm system of suitable type and a regularly organized fire drill.

(9) In fire drills the emphasis should be placed upon orderly controlled exit rather than speed alone. Drill procedure should be sufficiently flexible so that it can meet any emergency. For example, should a fire occur in or near a main exit, the children should be marched to some other exit.

(10) School rooms with hazardous occupancies involving the use of highly combustible materials should be properly segregated or protected. The heater and fuel storage rooms should be suitably cut off.

(11) The installation of automatic sprinklers, either to protect the entire building or to cover basements and particularly hazardous portions, is commonly the most practicable and least expensive method of mitigating the life hazard from fire in old fire-trap schools.

(12) Existing buildings present a different and ordinarily more difficult problem than new constructions. Some of the older school buildings, hazardous to life in their construction and arrangement, present a difficult problem because school authorities are often reluctant to make the expenditures necessary to safeguard such structures. The construction, arrangement and occupancy of the individual building will determine the nature and extent of necessary safety measures.

SUMMARY

Studies of explosions and fires in school buildings have developed the following facts:

(1) Explosions of natural gas have been responsible for three serious accidents involving school structures. In the school disaster at New London, Texas on March 18, 1937, 293 lives were lost. In the three cases the natural gas did not carry a malodorant to give warning of leaks.

(2) In 60 school fires since 1903, 827 lives were lost of which 678 were children.

(3) The number of recorded deaths among those fighting school fires is far greater than in other similar occupancies - perhaps due to structural conditions or because of a zeal in fire fighting due to a special sense of responsibility for the safety of schools.

(4) In school fires involving the loss of 470 lives, inadequate exit facilities were responsible for almost 2/3 of the life loss.

(5) The loss of life per fatal school fire is high, 13.8 persons. This figure is greater than the figure of 8.3 per fire for institutional occupancies.

(6) Almost 80 percent of the loss of life occurred in elementary schools and high schools.

(7) There have been eight major school disasters in which 693 lives have been lost.

(8) Fires occur in school property in the United States at the rate of six or seven a day with an estimated yearly loss of over $6,000,000.

(9) In a study of 1,000 school fires 720, or 72% occurred in classroom buildings and 165, or 165% in dormitories.

(10) The following seven causes were responsible for 75 percent of the school fires:

(a) Electrical causes
(b) Smoking - matches
(c) Incendiary
(d) Defective or overheated heating equipment
(e) Spontaneous ignition
(f) Ignition of flammable liquids or gases
(g) Defective or overheated flues or chimney

CONCLUSION

The fire record in school buildings shows the limited extent to which public responsibility has been met in safeguarding school children from fire.

The modern trend in school building construction represents a distinct improvement in construction and exit arrangements over that prevailing a generation ago. Many of the more recently built school buildings are of first-class fire-resistive construction with ample exits. There are still, however, a large number of schools being built in which "fire safety" has not received sufficient consideration. Local officials must maintain close contact with conditions existing in their schools if hazardous conditions are to be eliminated. The parents directly concerned, as well as the public at large, should see that the knowledge now available for the safety and protection of our boys and girls is applied in every possible manner.